



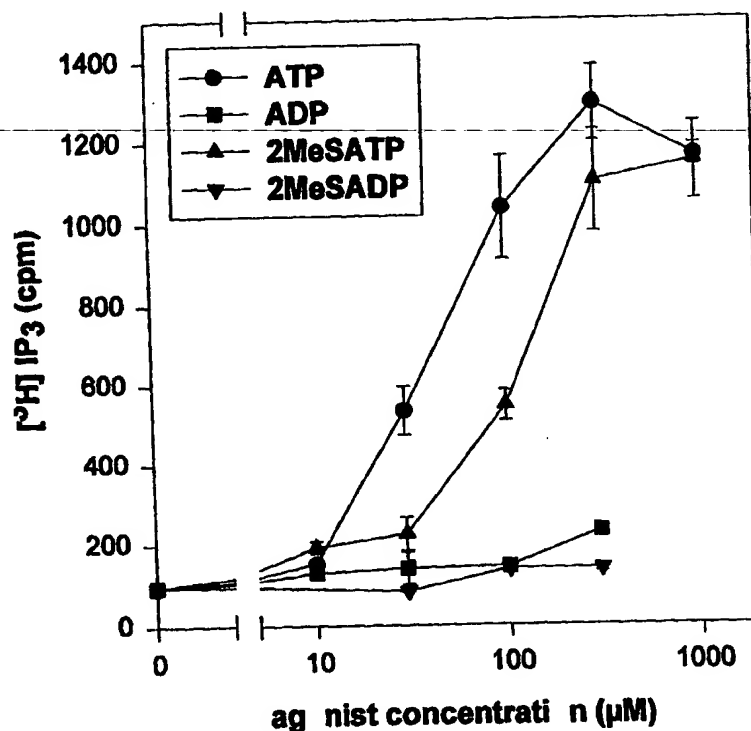
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(54) Title: G-COUPLED RECEPTOR SHOWING SELECTIVE AFFINITY FOR ATP

(57) Abstract

The present invention concerns a G-coupled receptor which has an amino acid sequence having more than 50 % homology with the amino-acid-sequence shown in Figure 1.



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G-COUPLED RECEPTOR SHOWING SELECTIVE AFFINITY FOR ATP

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Object of the present invention

The present invention concerns a new G protein-coupled receptor having selective affinity for ATP and the nucleic acid molecule encoding said receptor, vectors comprising said nucleic acid molecule, cells transformed by said vector, antibodies directed against said receptor, nucleic acid probes directed against said nucleic acid molecule, pharmaceutical compositions comprising said products and non human transgenic animals expressing the receptor according to the invention or the nucleic acid molecule according to said receptor.

Background of the invention

An impressive number of P2 receptors subtypes has been cloned since 1993. A new molecular nomenclature has then been created in which G protein-coupled P2 receptors have been named P2Y while P2 receptors having an intrinsic ion channel activity have been named P2X. The P2Y family encompasses selective purinoceptors (the P2Y₁ receptor activated by ATP and ADP), nucleotide receptors responsive to both adenine and uracil nucleotides (P2Y₂ receptor: activated equipotentially by ATP and UTP) and pyrimidinoceptors (the P2Y₃ and P2Y₆ receptors activated by UDP; the P2Y₄ receptor: activated by UTP). The

P2Y₅ and P2Y₇ receptors display limited homologies with the other members of the P2Y family. They have been included in this family especially on the basis of radioligand binding studies showing affinities for adenine nucleotides (1-18).

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Summary of the invention

The present invention concerns a new receptor having the amino acids sequence of figure 1 or any receptor which presents more than 50%, preferably more than 70%,
10 more preferably more than 85%, more specifically more than 95% homology with the amino acids sequence of figure 1.

The present invention concerns also the receptor having at least the amino acids sequence of figure 1 or a portion thereof, preferably an amino acids sequence
15 wherein the large extracellular part (the NH₂ portion of 450 amino acids sequence the end of which (♦) is represented on Fig. 1) has been truncated or active parts of said portion such as the sixth and seventh transmembrane domains comprising the amino acids : His⁶⁸⁶, Arg⁶⁸⁹ and
20 Arg⁷²⁸.

The present invention is also related to said NH₂ portion of 450 amino acids sequence, including peptides reproducing or mimicking a portion of this sequence or of organic molecules sharing the effects of these peptides.

25 Indeed, the inventors have discovered that either the whole receptor having the amino acids sequence of figure 1 or its portion (preferably the amino acids sequence wherein the large extracellular part of 450 amino acids has been truncated and starting from (♦) in Fig. 1)
30 seems to have the same industrial application (said portion will be identified hereafter as the P2Y₁₁ receptor or sequence).

The first industrial application of this receptor or its portions is the screening of agonists and

antagonists of said receptor which may have advantageous pharmaceutical or diagnostical properties. The second industrial application of the receptor according to the invention or of its portions or of active parts of its portions is the identification of patients who may present genetic disorders induced by an inactive receptor or by an inactive portion of said receptor.

According to a preferred embodiment of the present invention, said receptor is a human receptor.

ATP seems to be the preferential natural agonist of this receptor : UTP, UDP, AP₄A, AP₆A, AMP and adenosine seem to be unable to stimulate the phosphoinositide pathway or were much less potent than ATP.

Therefore, the invention is also related to a new G-coupled receptor, its portions or active parts of its portions having a selective affinity for ATP. "A selective affinity for ATP" means that ATP is able to induce the formation of a functional response (preferably the accumulation of Inositol triphosphate IP₃ and a rise of intracellular Ca²⁺) in a short time of incubation with said agonist (preferably in less than 5 min, more preferably less than 1 min) while the other known agonists of P₂Y (UTP, UDP, AP₄A, AP₆A, AMP and adenosine were unable to stimulate said receptor or were much less potent than ATP and induce a detectable functional response by said receptor.

The present invention is also related to a nucleic acid molecule, such as a DNA molecule or an RNA molecule, encoding the receptor, its portions or active parts of its portions according to the invention.

Preferably, said DNA molecule is a cDNA molecule or a genomic DNA molecule.

Preferably, said nucleic acid molecule has more than 50%, preferably more than 70%, more preferably

more than 85%, more specifically more than 95% homology with the DNA sequence shown in figure 1.

Preferably, the invention is related to a nucleic acid molecule which has more than 50%, preferably
5 more than 70%, more preferably more than 85%, more specifically more than 95% homology with this DNA sequence (shown in the figure 1), wherein the DNA sequence encoding the 450 amino acids of the NH₂ portion were truncated.

The present invention is also related to the
10 vector comprising the nucleic acid molecule according to the invention. Preferably, said vector is adapted for expression in a cell and comprises the regulatory elements necessary for expressing the amino acid molecule in said cell operatively linked to the nucleic acid sequence
15 according to the invention as to permit expression thereof.

Preferably, said cell is selected from the group consisting of bacterial cells, yeast cells, insect cells or mammalian cells. The vector according to the invention is a plasmid or a virus, preferably a
20 baculovirus, an adenovirus or a semliki forest virus.

The present invention concerns also the cell transformed by the vector according to the invention, said cell is preferably non-neuronal in origin and is selected from the group consisting of a COS-7 cell, a CHO cell, an
25 LM(tk-) cell, an NIH-3T3 cell or a 1321N1 astrocytoma cell.

The present invention is also related to a nucleic acid probe comprising the nucleic acid molecule according to the invention, of at least 15 nucleotides capable of specifically hybridising with a unique sequence
30 included in the sequence of the nucleic acid molecule encoding the receptor according to the invention. Said nucleic acid probe may be a DNA or an RNA molecule.

The invention concerns also an antisense oligonucleotide having a sequence capable of specifically
35 hybridising to an mRNA molecule encoding the receptor according to the invention so as to prevent translation of

said mRNA molecule or an antisense oligonucleotide having a sequence capable of specifically hybridising to the cDNA molecule encoding the receptor according to the invention.

Said antisense oligonucleotide may comprise
5 chemical analogs of nucleotide or substances which inactivate mRNA, or be included in an RNA molecule endowed with ribozyme activity.

Another aspect of the present invention concerns a ligand (preferably an antibody) other than known
10 molecules, especially the ATP, capable of binding to the receptor according to the invention and an anti-ligand (preferably also an antibody) capable of competitively inhibiting the binding of said ligand to the receptor according to the invention.

15 Preferably, said antibody is a monoclonal antibody directed to an epitope of the receptor according to the invention and present on the surface of a cell expressing said receptor.

The invention concerns also the
20 pharmaceutical composition comprising an effective amount of oligonucleotide according to the invention, effective to decrease the activity of said receptor by passing through a cell membrane and binding specifically with mRNA encoding the receptor according to the invention in the cell so as
25 to prevent its translation. The pharmaceutical composition comprises also a pharmaceutically acceptable carrier capable of passing through said cell membrane.

Preferably, in said pharmaceutical composition, the oligonucleotide is coupled to a substance,
30 such as a ribozyme, which inactivates mRNA.

Preferably, the pharmaceutically acceptable carrier comprises a structure which binds to a receptor on a cell capable of being taken up by cell after binding to the structure. The structure of the pharmaceutically
35 acceptable carrier in said pharmaceutical composition is

capable of binding to a receptor which is specific for a selected cell type.

Preferably, said pharmaceutical composition comprises an amount of the antibody according to the invention effective to block the binding of a ligand to the receptor according to the invention and a pharmaceutically acceptable carrier.

The present invention concerns also a transgenic non human mammal overexpressing (or expressing ectopically) the nucleic acid molecule encoding the receptor according to the invention.

The present invention also concerns a transgenic non human mammal comprising a homologous recombination knockout of the native receptor according to the invention.

According to a preferred embodiment of the invention, the transgenic non human mammal whose genome comprises antisense nucleic acid complementary to the nucleic acid according to the invention is so placed as to be transcribed into antisense mRNA which is complementary to the mRNA encoding the receptor according to the invention and which hybridises to mRNA encoding said receptor, thereby reducing its translation. Preferably, the transgenic non human mammal according to the invention comprises a nucleic acid molecule encoding the receptor according to the invention and comprises additionally an inducible promoter or a tissue specific regulatory element.

Preferably, the transgenic non human mammal is a mouse.

The invention relates also to a method for determining whether a ligand as an agonist or an antagonist of the receptor according to the invention can be specifically bound to said receptor; said method comprising the steps of contacting a cell or a cell extract from cells transfected with a vector according to the invention and expressing the nucleic acid molecule encoding said

receptor, possibly isolating a membrane fraction from the cell extract, contacting the ligand with the membrane fraction or with the cell under conditions permitting binding of said ligand to the receptor and detecting, possibly by means of a bioassay such as a modification in the second messenger concentration or a modification in the cellular metabolism (preferably determined by the acidification rate of the culture medium), an increase in the receptor activity), thereby determining whether the ligand binds to the receptor, possibly as an agonist or as an antagonist of said receptor.

Preferably, the second messenger assay comprises measurement of intracellular cAMP, intracellular inositol phosphate (IP3), intracellular diacylglycerol (DAG) concentration or intracellular calcium mobilisation.

Preferably, the cell used in said method is a mammalian cell non neuronal in origin, such as a COS-7 cell, a CHO cell, a LM(tk-) cell an NIH-3T3 cell or 1321N1 cell. In said method, the ligand is not previously known.

The invention is also related to the ligand isolated and detected by any of the preceding methods.

The present invention concerns also the pharmaceutical composition which comprises an effective amount of an agonist or an antagonist of the receptor according to the invention, effective to reduce the activity of said receptor and a pharmaceutically acceptable carrier.

The P2Y11 transcripts (obtained from the nucleotidic sequence starting from (♦) in Fig. 1) are detectable in HL-60 human leukaemia cells. Expression of P2Y11 receptor mRNA is increased by agents (riboic acid, DMSO) known to induce the granulocytic differentiations of HL-60 cells. However, the P2Y11 transcripts could not be detected in mature neutrophils. Therefore, a first industrial application of the product according to the invention is the diagnostic of leukaemia, preferably by

Northern blot analysis using the nucleotidic sequence encoding the P2Y₁₁ receptor according to the invention.

The present invention is also related to a diagnostic device or kit comprising the elements for the
5 diagnostic of specific leukaemia, preferably HL-60 human leukaemia, comprising the receptor according to the invention, the nucleic acid sequence encoding said receptor, a nucleic acid probe comprising the nucleic acid molecule according to the invention of at least 15
10 nucleotides capable of specifically hybridising with a unique sequence included in the sequence of the nucleic acid molecule encoding the receptor according to the invention, such as an antisense oligonucleotide or a ligand such as an antibody, preferably a monoclonal antibody,
15 capable of binding or competitively inhibiting the binding of a ligand to the receptor according to the invention. Said diagnostic device or kit could be used for the specific diagnostic or for the monitoring of the evolution of tumoral cells, especially leukaemia HL-60 cells.

20 Therefore, the previously described methods may be used for the screening of drugs (having advantageously anti-tumoral properties) which specifically bind to the receptor according to the invention.

Another industrial application of the present
25 invention is related to the use of said drugs, preferably ligands or anti-ligands according to the invention, for the prevention and/or the treatment of specific diseases such as neutropenie or agranulocytose infections or cancer.

The invention is also related to the drugs
30 isolated and detected by any of these methods.

The present invention concerns also a pharmaceutical composition comprising said drugs and a pharmaceutically acceptable carrier.

The invention is also related to a method of
35 detecting expression of a receptor according to the invention by detecting the presence of mRNA coding for a

receptor, which comprises obtaining total RNA or total mRNA from the cell and contacting the RNA or mRNA so obtained with the nucleic acid probe according to the invention under hybridising conditions and detecting the presence of
5 mRNA hybridised to the probe, thereby detecting the expression of the receptor by the cell.

The hybridisation conditions above-described are preferably standard stringent conditions as described by Sambrook et al. (§9.47-9.51 in Molecular Cloning :
10 Laboratory Manual, Cold Spring Harbour, Laboratory Press, New York (1989)).

The present invention concerns also a method for diagnosing a predisposition to a disorder associated with the activity of the receptor according to the
15 invention. Said method comprises:

- a) obtaining nucleic acid molecules of subjects suffering from said disorder;
- b) performing a restriction digest of said nucleic acid molecules with a panel of restriction enzymes;
- 20 c) electrophoretically separating the resulting nucleic acid fragments on a sized gel;
- d) contacting the resulting gel with a nucleic acid probe capable of specifically hybridising to said nucleic acid molecule and labelled with a detectable marker;
- 25 e) detecting labelled bands which have hybridised to the said nucleic acid molecule labelled with a detectable marker to create a unique band pattern specific to subjects suffering from said disorder;
- f) preparing nucleic acid molecules obtained for diagnosis
30 by step a-e; and
- g) comparing the unique band pattern specific to the nucleic acid molecule of subjects suffering from the disorder from step e and the nucleic acid molecule obtained for diagnosis from step f to determine whether
35 the patterns are the same or different and to diagnose

thereby predisposition to the disorder if the patterns are the same.

A last aspect of the present invention concerns a method of preparing the receptor according to the invention, which comprises:

- a) constructing a vector adapted for expression in a cell which comprises the regulatory elements necessary for the expression of nucleic acid molecules in the cell operatively linked to nucleic acid molecule encoding said receptor so as to permit expression thereof, wherein the cell is selected from the group consisting of bacterial cells, yeast cells, insect cells and mammalian cells;
- b) inserting the vector of step a in a suitable host cell;
- c) incubating the cell of step b under conditions allowing the expression of the receptor according to the invention;
- d) recovering the receptor so obtained; and
- e) purifying the receptor so recovered, thereby preparing an isolated receptor according to the invention.

Brief description of the drawings

Figure 1 represents the nucleotide and deduced amino acid sequence of the new human P2Y receptor. The putative phosphorylation sites by protein kinase C or by calmodulin-dependent protein kinases are indicated respectively by a black circle (●) or a black diamond (◆). The potential N-glycosylation site is indicated by a black square (■).

Figure 2 represents dendrogram of the structural relatedness of the P2Y₁₁ receptor with the other P2Y subtypes. The plot was constructed using the multiple sequence alignment program Pileup of the GCG package. The P2Y₅-like published sequence (18) is identical to the P2Y₉ sequence submitted to the GenBank/EMBL Data Bank.

Figure 3 represents Northern blot analysis of P2Y₁₁ messenger expression. Each lane of the MTN blot contains 2 µg of polyA⁺ RNA from several human tissues. Each lane of the HL-60 blot contains 10 µg of total RNA from 5 differentiated or undifferentiated HL-60 cells. Hybridization with the probe was performed as described under Materials and Methods. The pictures of the MTNII blot and the HL-60 blot were obtained respectively, from an autoradiography and from a PhosphorImager SI (Molecular Dynamics). The 2kb-length P2Y₁₁ transcripts are indicated by a black arrow.

Figure 4 represents concentration-action curves of several nucleotides on IP₃ and cAMP accumulation in cells transfected with the P2Y₁₁ receptor. 1321N1 and CHO-K1 15 transfected cells were assayed for the accumulation of, respectively, IP₃ (A) or cAMP (B) in response to various concentrations of the following nucleotides: ATP, 2MeSATP, ADP and 2MeSADP. Incubation times were 30 s for IP₃ measurements and 15 min for cAMP assays. The data represent 20 the means ± S.D. of triplicate experimental points and are representative of two independent experiments.

Description of a preferred embodiment of the present invention

25 Experimental Procedures

Materials

Trypsin was from Flow Laboratories (Bioggio, Switzerland). Culture media, G418, fetal calf serum (FCS), restriction enzymes and Taq polymerase were purchased from 30 GIBCO BRL (Grand Island, NY). The radioactive products myo-D-[2-³H]inositol (17.7 Ci/mmol) and [α-³²P]ATP (800 Ci/mmol) were from Amersham (Ghent, Belgium). Dowex AG1X8 (formate form) was from Bio-Rad Laboratories (Richmond, Calif.). ATP, ADP, AMP, adenosine, UTP, UDP, AP₄A, AP₆A, all-trans

retinoic acid (RA) and 12-O-tetradecanoylphorbol-13-acetate (TPA) were obtained from Sigma Chemical Co. (St. Louis, MO). 2-methylthio-ATP (2MeSATP), 2-methylthio-ADP (2MeSADP) and 8 (p-sulfophenyl) theophylline were from Research Biochemicals International (Natick, MA). Forskolin was purchased from Calbiochem (Bierges, Belgium). Indomethacin and dimethyl sulfoxide (DMSO) were from Merck (Netherlands). Rolipram was obtained from the Laboratoires Jacques Logeais (Trappes, France). The HL-60 human cell line was obtained from the American Type Culture Collection (Rockville, USA). The human genomic DNA library was from Stratagene (La Jolla, CA). pEFIN3 is an expression vector obtained from Euroscreen (Brussels, Belgium). Multiple Human Tissues Northern blot (MTN) were from Clontech (Palo Alto, CA).

Cloning and sequencing

A human placenta cDNA library was screened at moderate stringency with an [$\alpha^{32}\text{P}$] dATP labelled P2Y₄ receptor probe corresponding to a partial sequence covering the third to the seventh transmembrane segments. Three overlapping clones encoding a new G protein-coupled receptor were isolated, but did not contain the 3' end of the coding region. A human genomic DNA library was then screened with this partial sequence to obtain the complete sequence of this new receptor. The hybridization conditions for screening the two libraries were 6 X SSC (1 X SSC: 0.15 M NaCl, 0.015 M sodium citrate) and 40% formamide at 42 °C for 14 hours and the final washing conditions were 0.5 X SSC, 0.1% SDS at 60 °C. Four genomic clones were purified and shown to contain the 3' end of the open reading frame missing in the cDNA clones. The sequence was obtained on both strands after subcloning of overlapping restriction fragments in M13mp18 and M13mp19 using the Sanger dideoxy nucleotide chain termination method.

Northern blot analysis

Two blots of human organs (MTN I and MTN II: 2 µg polyA⁺ RNA/lane) and a blot containing total RNA from 5 differentiated and undifferentiated HL-60 cells (10 µg of total RNA/lane) were hybridized with a probe corresponding to the new receptor in order to characterize its tissue distribution. The HL-60 cells were maintained in RPMI 1640 supplemented with 10% FCS, 5 mM L-glutamine, 50 U/ml 10 penicillin and 50 µg/ml streptomycin at 37 °C with 5% CO₂. The HL-60 cells were incubated during six days with or without 1 µM retinoic acid or 1.25% DMSO or during eight hours with 25 nM TPA. The RNA from the differentiated or undifferentiated HL-60 cells was prepared with the RNeasy 15 kit (Quiagen). The blots were prehybridized 8 hours at 42 °C in a 50% formamide, 2% SDS solution and hybridized for 18 hours in the same solution supplemented with the [α^{32} P] labelled probe. The final washing conditions were 0.1 X SSC and 0.1% SDS at 55 °C. The blots were exposed 20 during twelve days and visualized as an autoradiography or using the PhosphorImager SI (Molecular Dynamics).

Cell culture and transfection

The complete sequence of the new receptor 25 according to the invention was subcloned between the Hind III and Nhe I sites of the bicistronic pEFIN3 expression vector. 1321N1 and CHO-K1 cells were transfected with the recombinant pEFIN3 plasmid or with the plasmid alone using the calcium phosphate precipitation method as described 30 (19). The transfected cells were selected with 400 µg/ml G418 in complete medium (10% FCS, 100 units/ml penicillin, 100 µg/ml streptomycin and 2.5 µg/ml amphotericin B in Dulbecco's modified Eagle's medium (DMEM)) two days after transfection and maintained in the same medium (10).

Inositol phosphates (IP) measurement

1321N1 cells were labelled for 24 hours with 10 mCi/ml [³H] inositol in inositol free DMEM containing 5% FCS, antibiotics, amphotericin, sodium pyruvate and 400 µg/ml G418. Cells were washed twice with Krebs-Ringer Hepes (KRH) buffer of the following composition (124 mM NaCl, 5 mM KCl, 1.25 mM MgSO₄, 1.45 mM CaCl₂, 1.25 mM KH₂PO₄, 25 mM Hepes (pH:7.4) and 8 mM glucose) and incubated in the same medium for 30 min. The cells were then challenged by various nucleotides for 30 s. The incubation was stopped by the addition of an ice cold 3% perchloric acid solution. IP were extracted and separated on Dowex columns as previously described (20).

15 Cyclic AMP measurements

Stably transfected CHO-K1 or 1321N1 cell lines were spread on Petri dishes (150.000 cells per dish) and cultured in Ham's F12 or DMEM medium containing 10% FCS, antibiotics, amphotericin, sodium pyruvate and 400 µg/ml G418. Cells were preincubated for 30 min in KRH buffer with rolipram (25 µM) and incubated for different times in the presence of the agonists (15 min in most experiments). The incubation was stopped by the addition of 1 ml HCl 0.1 M. The incubation medium was dried up, resuspended in water and diluted as required. Cyclic AMP was quantified by radioimmunoassay after acetylation as previously described (21).

Results30 Cloning and Sequencing

A human cDNA placenta library was screened at moderate stringency with a human P2Y₄ probe. Nine clones which hybridized weakly with the P2Y₄ probe were obtained, purified and analyzed. Six of them corresponded to the

sequence of the P2Y₆ receptor (10) while three overlapping clones corresponded to a partial sequence encoding a new G protein-coupled receptor, displaying about 30% identity with the other P2Y receptors. The partial open reading
5 frame started with an ATG-codon in a Kozak consensus but the 3' end was missing in all three cDNA clones. The Inventors screened a human genomic DNA library using this partial sequence as a probe. Four overlapping genomic clones were obtained. Mapping of the coding sequence and
10 partial sequencing allowed to determine that the gene encoding the new receptor contains an intron interrupting the coding sequence at the 5' end of the gene. This intron separates the three first codons from the rest of the coding sequence. Beside these first codons, the four
15 genomic clones contained the complete open reading frame including the 3' end missing in the cDNA clones. The full open reading frame appeared as 1113 base pairs (bp) long and encoded a protein of 371 amino acids containing one potential site for N-linked glycosylation and two potential
20 sites for phosphorylation by protein kinase C or calmodulin-dependent protein kinases (Fig. 1). The new receptor, provisionally named P2Y₁₁, displays significant homologies with the other P2Y receptors (Fig. 2). In particular, 33% and 28 % amino acid identity were observed
25 respectively with the human P2Y₁ and P2Y₂ receptors.

Tissue distribution of the new receptor

The tissue distribution of the new receptor transcripts was investigated by Northern blotting (Fig. 3)
30 by using a probe corresponding to a partial sequence encoding transmembrane segments 3 to 7. The strongest signal was observed for human spleen and corresponded to a 2 kilobase (kb)-length messenger RNA (MTN II). A weaker signal was observed in small intestine (MTN II). All the
35 lanes in MTN I (heart, brain, placenta, lung, liver,

skeletal muscle, kidney, pancreas) were negative. The Inventors also detected specific 2 kb-length transcripts in HL-60 cells. The signal was very weak in the undifferentiated HL-60 cells but increased when the cells had been treated with retinoic acid or DMSO. No increase was observed when the HL-60 cells were stimulated with TPA. A weak non-specific hybridization with 18S rRNA was observed. These data were confirmed with a non-overlapping probe corresponding to the first 300 bp of the coding region, presenting limited homologies with the other P2Y subtypes.

Functional Expression of the new receptor in 1321N1 astrocytoma cells

The complete sequence of the new receptor was introduced in the pEFIN3 expression vector in order to transfect the 1321N1 astrocytoma cell line, used previously to characterize several P2Y subtypes (6, 10, 12). The pool of G418-resistant clones was tested for its functional response to several nucleotides. ATP (100 μ M) induced a strong inositol trisphosphate (IP₃) accumulation in cells transfected with the recombinant plasmid, whereas ADP, AMP, adenosine, UTP, UDP, AP₄A and AP₆A were inactive at the same concentration. All nucleotides were totally inactive on the cells transfected with the vector alone. We then tested ATP, 2MeSATP, ADP and 2MeSADP in a large range of concentrations. As shown in Fig. 4A, ATP was the most potent agonist (EC₅₀ ATP = 38 ± 7 μ M; EC₅₀ 2MeSATP = 118 ± 15 μ M; means \pm range of two independent experiments). The effect of ADP and 2MeSADP were minimal. Pertussis toxin (50 ng/ml; 24 h pretreatment) had no effect on the ATP response, whereas a lower concentration of pertussis toxin was previously shown to abolish the response to UTP in P2Y₄ transfected 1321N1 astrocytoma cells (22). A response to ATP (10 μ M) was also obtained following [Ca²⁺]_i

measurements performed on the 1321N1 transfected cells while ADP was inactive at this concentration.

Functional expression of the new receptor in CHO-K1 cells

5 The 1321N1 cells transfected with the new receptor displayed a strong cAMP increase in response to ATP. A much lower but significant endogeneous response due to the degradation of adenine nucleotides into adenosine was also obtained in the 1321N1 cells transfected with the
10 vector alone. The CHO-K1 cells express an endogeneous P2Y₂ receptor coupled to the phosphoinositide pathway (23) but do not possess adenosine receptors coupled to adenylyl cyclase. We therefore used CHO-K1 cells in order to characterize the coupling of the new receptor to the cAMP
15 pathway. A pool of G418 resistant CHO-K1 clones was first tested for its response to several nucleotides at a concentration of 100 μ M. ATP was able to induce a strong increase in the cAMP content, whereas it was inactive on cells transfected with the vector alone. ADP, AMP,
20 adenosine, UTP and UDP were completely inactive. Concentration-action curves were established for ATP,

2MeSATP, ADP and 2MeSADP (Fig. 4B). The rank order of potency was the same as in the inositol phosphate study on 1321N1 cells. The curves were obtained after 15 min of
25 stimulation by the agonists; however a significant cAMP response to ATP was already obtained after 2 min of stimulation. The response to ATP (30 μ M) was inhibited neither by indomethacin (10 μ g/ml, present from 30 minutes before the stimulation and readed in the stimulation
30 medium) nor by 8 (p-sulfophenyl) theophylline (100 μ M).

The receptor according to the invention presents some structural peculiarities which differentiate it from some other P2Y subtypes. Concerning its gene structure, the coding sequence is interrupted by an intron.
35 Comparison between the cDNA and the genomic DNA sequences has clearly demonstrated the absence of intron in the

coding region of the human P2Y₁ receptor (24, 25), the rat P2Y₂ receptor (26) and the rat P2Y₆ receptor (11). In terms of protein structure, the second and third extracellular loops are significantly longer than those of the other P2Y receptors. The homology with the other subtypes is relatively weak (about 30%). The closest G-coupled receptor is the human P2Y₁ receptor (33%) which is also a receptor responsive to adenine nucleotides (3, 4). Mutagenesis experiments with the P2Y₂ receptor have identified three positively charged amino acids in the sixth and seventh transmembrane domains (His²⁶², Arg²⁶⁵ and Arg²⁹²), which play a crucial role in nucleotide binding (presumably by neutralizing the negative charge of the phosphate groups) (27). These three residues are conserved in this new receptor.

So far, eight P2Y receptor subtypes are described in the literature (P2Y₁-P2Y₈). In addition, two sequences related to the P2Y₅ receptor and named P2Y₉ and P2Y₁₀, have been recently submitted to the GenBank/EMBL Data Bank. The P2Y₉ sequence is identical to that recently published under the name "P2Y₅-like" (18). Therefore the new receptor described in this paper might be called P2Y₁₁. However, it is already clear that the nomenclature needs a revision. It was recently demonstrated that the P2Y₇ receptor is actually a receptor for leukotriene B₄ (16) and there is no functional evidence that the P2Y₅ and related receptors (P2Y₅-like or P2Y₉, P2Y₁₀) are nucleotide receptors (17, 18).

Among the sixteen human organs tested by Northern blotting, P2Y₁₁ transcripts of 2 kb size were only detectable in spleen, and with lower intensity in small intestine. This distribution is reminiscent of that of the human P2Y₆ 1.7 kb-messenger. The observation of the

expression of the P2Y₁₁ receptor in the HL-60 cell line shows that this expression was strongly increased following treatment by DMSO or retinoic acid, two agents known to induce the differentiation of these cells into granulocytes (28). On the contrary, TPA, which is known to induce the monocytic differentiation of the HL-60 cells (29), did not stimulate the expression of the P2Y₁₁ receptor. The confirmation of these data with a second probe of the P2Y₁₁ cDNA, that shares little similarity with other P2Y sequences, excludes possible cross-hybridization with another P2Y receptor transcript. In view of the Northern blots results, it is tempting to speculate that the P2Y₁₁ receptor is involved in the recently described accumulation of cAMP in ATP-stimulated HL-60 cells (30).

Among the P2Y receptors, the P2Y₁₁ subtype has the unique property to activate both the phosphoinositide and the cAMP pathways. Other cloned P2Y receptors are coupled to phospholipase C exclusively. The rank order of potency of agonists was the same for the two pathways. ATP was clearly much more potent than ADP. This difference may be even underestimated as a result of low level ATP contamination in ADP preparation or conversion of ADP into ATP during assays (4, 11). On the other hand, 2MeSATP had the same maximal effect than ATP but presented a lower potency, while 2MeSADP, a potent activator of the P2Y₁ and P2T subtypes (4), was almost inactive. The EC₅₀ values were comparable to those obtained in the study concerning the effects of extracellular nucleotides on the cAMP accumulation in the HL-60 cells (30).

Stimulatory effects of adenine nucleotides on the cAMP pathway have been described in different cell types (31, 32). In most cases, the stimulatory effect of nucleotides was inhibited by xanthines. These data suffer from the fact that it is difficult to exclude that the effect of adenine nucleotides is mediated by their

degradation into adenosine due to the ubiquitous presence of ectonucleotidases expressed at the cell surface. The cAMP study has been performed with CHO-K1 cells to avoid the endogenous cAMP response to adenosine in the astrocytoma cell line. Neither in untransfected CHO-K1 cells nor in P2Y₁₁-transfected CHO-K1 cells did adenosine increase cAMP accumulation. Furthermore the cAMP response to ATP was insensitive to xanthine inhibition. It was also insensitive to indomethacin, indicating that is not mediated by the release of prostaglandins. It is unlikely that the cAMP response would be an indirect consequence of the calcium response since the use of ATP, which activates the phosphoinositide pathway by the activation of P2Y₂ endogenous receptors, or the use of calcium ionophores in the CHO-K1 cells failed to stimulate cAMP accumulation (33). Therefore these data constitute the first strong evidence that a P₂ receptor can be coupled to the stimulation of adenylyl cyclase.

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CLAIMS.

1. Receptor which has an amino acid sequence having more than 50% homology with the amino acid sequence shown in Figure 1.

5 2. Receptor according to claim 1, which has at least the amino acid sequence shown in Figure 1 or a portion thereof.

3. Receptor according to claim 1 or 2 having a selective affinity ADP.

10 4. Receptor according to any of the preceding claims, belonging to the P₂Y receptor family.

5. Receptor according to any of the preceding claims, being a G protein-coupled receptor.

15 6. Receptor according to any of the preceding claims, being a human receptor.

7. Nucleic acid molecule encoding the receptor according to any of the preceding claims.

8. Nucleic acid molecule according to claim 7, wherein the nucleic acid molecule is DNA or RNA molecule.

20 9. DNA molecule according to claim 8, which is a cDNA molecule or a genomic DNA molecule.

10 10. Nucleic acid molecule according to any of the claims 7 to 9, having more than 50% homology to the DNA sequence shown in Figure 1.

11. DNA molecule according to claim 10, which has at least the DNA sequence as shown in figure 1 or a portion thereof.

30 12. Vector comprising the nucleic acid molecule according to any of the claims 7 to 11.

13. Vector according to claim 12, adapted for expression in a cell, which comprises the regulatory elements necessary for expression of the nucleic acid molecule in said cell operatively linked to the nucleic

acid molecule according to any of the claims 7 to 11 as to permit expression thereof.

14. Vector of claim 13, wherein the cell is selected from the group consisting of bacterial cells, yeast cells, insect cells or mammalian cells.

15. Vector according to any of the claims 12 to 14, wherein the vector is a plasmid or a virus, preferably a baculovirus, an adenovirus or a Semliki Forest virus.

16. Cell comprising the vector according to any of the claims 12 to 15.

17. Cell of claim 16, wherein the cell is a mammalian cell, preferably non neuronal in origin.

18. Cell of claim 16, wherein the cell is selected from the group consisting of COS-7 cells, CHO cells, LM(tk-) cells, NIH-3T3 cells or 1321N1 astrocytoma cells.

19. Nucleic acid probe comprising a nucleic acid molecule of at least 15 nucleotides capable of specifically hybridising with a unique sequence included within the nucleic acid molecule according to any of the claims 11 to 15.

20. Nucleic acid probe of claim 19, wherein the nucleic acid is DNA or RNA.

21. Antisense oligonucleotide having a sequence capable of specifically hybridising to a mRNA molecule of claim 8, so as to prevent translation of the mRNA molecule.

22. Antisense oligonucleotide having a sequence capable of specifically hybridising to the DNA molecule of claim 9.

23. Antisense oligonucleotide according to claim 21 or 22, comprising chemical analogs of nucleotides.

24. Ligand other than purine and pyridine nucleotides capable of binding to a receptor according to any of the claims 1 to 6.

25. Anti-ligand capable of competitively
5 inhibiting the binding of the ligand according to claim 24 to the receptor according to any of the claims 1 to 6.

26. Ligand according to claim 24, which is an antibody.

27. Anti-ligand according to claim 25, which
10 is an antibody.

28. Antibody according to claim 26 or 27, which is a monoclonal antibody.

29. Monoclonal antibody according to claim 28, directed to an epitope of the receptor according to any
15 of the claims 1 to 6, present on the surface of a cell expressing said receptor.

30. Pharmaceutical composition comprising an amount of the oligonucleotide according to claim 21, effective to decrease activity of the receptor according to
20 any of the claims 1 to 6 by passing through a cell membrane and binding specifically with mRNA encoding said receptor in the cell so as to prevent its translation, and a pharmaceutically acceptable carrier capable of passing through a cell membrane.

25 31. Pharmaceutical composition of claim 30, wherein the oligonucleotide is coupled to a substance which inactivates mRNA.

32. Pharmaceutical composition of claim 31, wherein the substance which inactivates mRNA is a ribozyme.

30 33. Pharmaceutical composition according to any of the claims 30 to 32, wherein the pharmaceutically acceptable carrier comprises a structure which binds to a receptor on a cell capable of being taken up by cell after binding to the structure.

34. Pharmaceutical composition of claim 33, wherein the structure of the pharmaceutically acceptable carrier is capable of binding to a receptor which is specific for a selected cell type.

5 35. Pharmaceutical composition which comprises an effective amount of the anti-ligand of claim 30, effective to block binding of a ligand to the receptor according to any of the claims 1 to 6 and a pharmaceutically acceptable carrier.

10 36. Transgenic non human mammal expressing the nucleic acid molecule according to any of the claims 7 to 11.

37. Transgenic non human mammal comprising a homologous recombination knockout of the native receptor
15 according to any of the claims 1 to 6.

38. Transgenic non human mammal whose genome comprises antisense nucleic acid complementary to the nucleic acid molecule according to any of the claims 7 to 11 so placed as to be transcribed into antisense mRNA
20 which is complementary to the mRNA of claim 8 and which
~~hybridises to said mRNA thereby reducing its translation.~~

39. Transgenic non human mammal according to any of the claims 36 to 38, wherein the nucleic acid according to any of the claims 7 to 11 additionally
25 comprises an inducible promoter.

40. Transgenic non human mammal according to any of the claims 36 to 39, wherein the nucleic acid according to claim 7 to 11 additionally comprises tissue specific regulatory elements.

30 41. Transgenic non human mammal according to any of the claims 36 to 40, which is a mouse.

42. Method for determining whether a ligand can specifically bind to a receptor according to any of the claims 1 to 6, possibly as an agonist or an antagonist of
35 said receptor; said method comprising the steps of :

contacting a cell or cell extract from cells transfected with a vector expressing the nucleic acid molecule encoding said receptor, possibly isolating a membrane fraction from the cell extract, with the ligand under conditions
5 permitting binding of said ligand to said receptor, possibly by the activation of a functional response, and detecting the presence of any such ligand bound specifically to said receptor, possibly by means of a bioassay such as a modification of the production of a
10 second messenger or an increasing in the receptor activity, thereby determining whether the ligand binds specifically to said receptor, possibly as an agonist or an antagonist of said receptor.

43. A method according to claim 42, wherein
15 the second messenger assay comprises measurement of intracellular cAMP, intracellular Inositol phosphate, intracellular diacylglycerol concentration or intracellular calcium mobilisation.

44. Method according to claim 42 or 43,
20 wherein the cell is a mammalian cell, preferably non neuronal in origin, and selected from the group consisting of COS-7 cells, CHO cells, LM(tk-) cells, NIH-3T3 cells or 1321N1 cells.

45. Method according to any of the preceding
25 claims 42 to 44, wherein the ligand is not previously known.

46. Ligand detected by the method according to any of the preceding claims 42 to 45.

47. Pharmaceutical composition which
30 comprises the ligand according to claim 46 and a pharmaceutically acceptable carrier.

48. Method of screening drugs to identify drugs which specifically bind to the receptor according to any of the claims 1 to 6 on the surface of the cell, which
35 comprises contacting a cell transfected with a vector

expressing the nucleic acid molecule encoding said receptor with a plurality of drugs under conditions permitting binding of said drugs to the receptor, and determining those drugs which specifically bind to the transfected
5 cell, thereby identifying drugs which specifically bind to the receptor.

49. Method of screening drugs to identify drugs which specifically bind to the receptor according to any of the claims 1 to 6 on the surface of the cell, which
10 comprises preparing a cell extract from cells transfected with a vector expressing the nucleic acid molecule encoding said receptor, isolating a membrane fraction from the cells extract, contacting the membrane fraction with a plurality of drugs and determining those drugs which bind to the
15 transfected cell, thereby identifying drugs which specifically bind to said receptor.

50. Method of screening drugs to identify drugs which act as agonists of the receptor according to any of the claims 1 to 6, which comprises contacting a cell
20 transfected with a vector expressing the nucleic acid molecule encoding said receptor with a plurality of drugs under conditions permitting the activation of a functional receptor response, and determining those drugs which activate such receptor using a bio-assay, such as a
25 modification in a second messenger concentration or modification in the cellular metabolism, thereby identifying drugs which act as receptor agonists.

51. Method of screening drugs to identify drugs which act as agonists of the receptor according to
30 any of the claims 1 to 6, which comprises preparing a cell extract from cells transfected with a vector expressing the nucleic acid molecule encoding said receptor, isolating a membrane fraction from the cell extract, contacting the membrane fraction with a plurality of drugs under
35 conditions permitting the activation of a functional receptor response, and determining those drugs which

activate such receptor using a bio-assay, such as a modification in a second messenger concentration, thereby identifying drugs which act as receptor agonists.

52. Method of screening drugs to identify
5 drugs which act as antagonists of the receptor according to
any of the claims 1 to 6, which comprises contacting a cell
transfected with a vector expressing the nucleic acid
molecule encoding said receptor with a plurality of drugs
in the presence of a known receptor agonist, under
10 conditions permitting the activation of a functional
receptor response, and determining those drugs which
inhibit the activation of the receptor using a bio-assay,
such as a modification in a second messenger concentration
or modification in the cellular metabolism, thereby
15 identifying drugs which act as receptor antagonists.

53. Method of screening drugs to identify
drugs which act as antagonists of the receptor according to
any of the claims 1 to 6, which comprises preparing a cell
extract from cells transfected with a vector expressing the
20 nucleic acid molecule encoding said receptor, isolating a
~~membrane fraction from the cell extract, contacting the~~
~~membrane fraction with a plurality of drugs in presence of~~
~~a known receptor agonist, under conditions permitting the~~
~~activation of a functional receptor response, and~~
25 determining those drugs which inhibit the activation of the
receptor using a bio-assay, such as a modification in a
second messenger concentration, thereby identifying drugs
which act as receptor antagonists.

54. Drug detected by any of the methods
30 according to claims 48 to 53.

55. Pharmaceutical composition comprising a
drug according to claim 54.

56. Method of detecting the expression of the
receptor according to any of the claims 1 to 6, by
35 detecting the presence of mRNA coding said receptor, which

comprises obtaining total RNA or total mRNA from the cell and contacting the RNA or mRNA so obtained with the nucleic acid probe according to claim 19 under hybridising conditions, and detecting the presence of mRNA hybridised to the probe, thereby detecting the expression of the receptor by the cell.

57. Method of detecting the presence of the receptor according to any of the claims 1 to 6 on the surface of a cell, which comprises contacting the cell with the antibody of claim 26 under conditions permitting binding of the antibody to the receptor, and detecting the presence of the antibody bound to the cell, thereby detecting the presence of the receptor on the surface of the cell.

58. Method of determining the physiological effects of expressing varying levels of the receptor according to any of the claims 1 to 6, which comprises producing a transgenic non human mammal according to any of the claims 36 to 41 whose levels of receptor expression are varied by use of an inducible promoter which regulates the receptor expression.

59. Method of determining the physiological effects of expressing varying levels of the receptor according to any of the claims 1 to 6, which comprises producing a panel of transgenic non human mammals according to any of the claims 36 to 41, each expressing a different amount of said receptor.

60. Method for identifying an antagonist of the receptor according to any of the claims 1 to 6 capable of alleviating an abnormality in a subject wherein the abnormality is alleviated by decreasing the activity of the receptor, which comprises administering the antagonist to a transgenic non human mammal according to any of the claims 36 to 41 and determining whether the antagonist alleviates the physical and behavioural abnormalities displayed by the

transgenic non human mammal as a result of receptor activity, thereby identifying the antagonist.

61. Antagonist identified by the method of claim 60.

5 62. Pharmaceutical composition comprising an antagonist according to claim 61 and a pharmaceutically acceptable carrier.

10 63. Method for identifying an agonist of the receptor according to any of the claims 1 to 6 capable of alleviating an abnormality in a subject wherein the abnormality is alleviated by activation of said receptor, which comprises administering the agonist to a transgenic non human mammal according to any of the claims 36 to 41 and determining whether the antagonist alleviates the
15 physical and behavioural abnormalities displayed by the transgenic non human mammal, the alleviation of the abnormalities indicating the identification of the agonist.

64. Agonist identified by the method of claim 63.

20 65. Pharmaceutical composition comprising an agonist according to claim 64 and a pharmaceutically acceptable carrier.

66. Method for diagnosing a predisposition to a disorder associated with the activity of a specific
25 allele of the receptor according to any of the claims 1 to 6, which comprises:

- a) obtaining nucleic acid molecules of subjects suffering from said disorder;
- b) performing a restriction digest of said nucleic acid
30 molecules with a panel of restriction enzymes;
- c) electrophoretically separating the resulting nucleic acid fragments on a sized gel;
- d) contacting the resulting gel with a nucleic acid probe capable of specifically hybridising to said nucleic
35 acid molecule and labelled with a detectable marker;

- e) detecting labelled bands which have hybridised to the said nucleic acid molecule labelled with a detectable marker to create a unique band pattern specific to subjects suffering from said disorder;
- 5 f) preparing nucleic acid molecules obtained for diagnosis by step a-e; and
- g) comparing the unique band pattern specific to the nucleic acid molecule of subjects suffering from the disorder from step e and the nucleic acid molecule
- 10 obtained for diagnosis from step f to determine whether the patterns are the same or different and to diagnose thereby predisposition to the disorder if the patterns are the same.

67. Method of preparing the purified receptor
- 15 according to any of the claims 1 to 6, which comprises:
- a) constructing a vector adapted for expression in a cell which comprises the regulatory elements necessary for the expression of nucleic acid molecules in the cell operatively linked to nucleic acid molecule encoding
- 20 said receptor so as to permit expression thereof, wherein the cell is selected from the group consisting of bacterial cells, yeast cells, insect cells and mammalian cells;
- b) inserting the vector of step a in a suitable host cell;
- 25 c) incubating the cell of step b under conditions allowing the expression of the receptor according to the invention;
- d) recovering the receptor so obtained; and
- e) purifying the receptor so recovered, thereby preparing
- 30 an isolated receptor according to the invention.

68. Use of the pharmaceutical composition according to claim 47, 55, 62 or 65, in the preparation of a medicament for the treatment and/or the prevention of the neutropenie, agranulocytose infections or cancer.

P2Y₁₁ sequence

FIG.1a

1 GAATTCGGCAGGAGGAGGCTCGTGGAGGACACAGCAGCATGGGACAGTCAGGGAGGTCC 20
1 60
21 R H Q K R A R A Q A Q L R N L E A Y A A 40
61 CGGCACCAGAAGCGCGCCCGCGCCAGGCGCAGCTCCGCAACCTCGAGGCCTATGCCGCG 120
41 N P H S F V F T R G C T G R N I R Q L S 60
121 AACCCGCACTCGTTCTGTTCACGCGAGGCTGCACGGGTGCAACATCCGGCAGCTCAGC 180
61 L D V R R V M E P L T A S R L Q V R K K 80
181 CTGGACGTGCGGCGGGTCATGGAGCCGCTCACTGCCAGCCGTCTGCAGGTTCTGTAAGAAG 240
81 N S L K D C V A V A G P L G V T H F L I 100
241 AACTCGCTGAAGGACTGCGTGGCAGTGGCTGGGCCCTCGGGGTACACACTTTCTGATC 300
101 L S K T E T N V Y F K L M R L P G G P T 120
301 CTGAGCAAAACAGAGACCAATGTCTACTTTAAGCTGATGCGCCTCCAGGAGGCCCCACC 360
121 L T F Q V K K Y S L V R D V V S S L R R 140
361 TTGACCTTCCAGGTGAAGAAGTACTCGCTGGTGCCTGATGTGGTCTCCTCACTGCGCCGG 420
141 H R M H E Q Q F A H P P L L V L N S F G 160
421 CACCGCATGCAGGAGCAGCAGTTTGGCCACCCACCCCTCCTGGTACTCAACAGCTTTGGC 480
161 P H G M H V K L M A T M F Q N L F P S I 180
481 CCCCATGGTATGCATGTGAAGCTCATGGCCACCATGTTCCAGAACCTGTCCCCCTCCATC 540
181 N V H K V N L N T I K R C L L I D Y N P 200
541 AACGTGCACAAGGTGAACCTGAACACCATCAAGCGGTGCCTCCTCATCGACTACAACCCC 600
201 D S Q E L D F R H Y S I K V V P V G A S 220
601 GAETCCCAGGAGCTGGACTTCCGCCACTATAGCATCAAAGTTGTTCTGTGGGCGCGAGT 660
221 R G M K K L L Q E K F P N M S R L Q D I 240
661 CGCGGGATGAAGAAGCTGCTCCAGGAGAAGTTCCCAACATGAGCCGCTGCAGGACATC 720
241 S E L L A T G A G L S E S E A E P D G D 260
721 AGCGAGCTGTGGCCACGGGCGGGGCTGTGCGAGAGCGAGGCAGAGCCTGACGGCGAC 780
261 H N I T E L P Q A V A G R G N M R A Q Q 280
781 CACAACATCACAGAGCTGCCTCAGGCTGTGCTGGCCGTGGCAACATGCGGGGCCAGCAG 840
281 S A V R L T E I G P R M T L Q L I K V Q 300
841 AGTGCAGTGGCGCTCACCGAGATCGGCGCGGGATGACACTGCAGCTCATCAAGGTCCAG 900
301 E G V G E G K V M F H S F V S K T E E E 320
901 GAGGGCGTGGGGAGGGCAAGTGTGTTCCACAGTTTGTGAGCAAGACGGAGGAGGAG 960
321 L Q A I L E A K E K K L R L K A Q R Q A 340
961 CTGCAGGCCATCCTGGAGCCCAAGGAGAAGAAGCTGCGGCTGAAGGCGCAGAGGCAGGCC 1020
341 Q Q A Q N V Q R K Q E Q R E A H R K K S 360
1021 CAGCAGGCCAGAAATGTGCGAGCGCAAGCAGGAGCAGCGGGAGGCTTACAGAAAGAAGAGC 1080

FIG. 1b

361 L E G M K K A R V G G S D E E A S G I P 380
1081 CTGGAGGGCATGAAGAAGGCACGGGTGCGGGGTAGTGATGAAGAGGCCTCTGGGATCCCT 1140

381 S R T A S L E L G E D D D E Q E D D D I 400
1141 TCAAGGACGGCGAGCCTGGAGTTGGGTGAGGACGATGATGAACAGGAAGATGATGACATC 1200

401 E Y F C Q A V G E A P S E D L F P E A K 420
1201 GAGTATTTCTGCCAGGCGGTGGGCGAGGCGCCAGTGAGGACCTGTTCCCCGAGGCCAAG 1260

421 Q K R L A K S P G R K R K R W E M D R G 440
1261 CAGAAACGGCTTGCCAAGTCTCCAGGGCGGAAGCGGAAGCGGTGGGAATGGATCGAGGT 1320

441 A K S C P A N F L A A A D D K L S G F Q 460
1321 GCCAAGTCTGCCCTGCCAACTTCTTGGCAGCTGCCGACGACAACTCAGTGGGTTCAG 1380

461 G D F L W P I L V V E F L V A V A S N G 480
1381 GGGGACTTCTGTGGCCATACTGGTGGTTGAGTTCCTGGTGGCCGTGGCCAGCAATGGC 1440

481 L A L Y R F S I R K Q R P W H P A V V F 500
1441 CTGGCCCTGTACCGCTTCAGCATCCGGAAGCAGCGCCCATGGCACCCCGCCGTGGTCTTC 1500

501 S V Q L A V S D L L C A L T L P P L A A 520
1501 TCTGTCCAGCTGGCAGTCAGCGACCTGCTCTGCGCTCTGACGCTGCCCCGCTGGCCGCC 1560

521 Y L Y P P K H W R Y G E A A C R L E R F 540
1561 TACCTCTATCCCCCAAGCACTGGCGCTATGGGGAGGCCGCGTGCCGCCTGGAGCGCTTC 1620

541 L F T C N L L G S V I F I T C I S L N R 560
1621 CTCTTCACCTGCAACCTGCTGGGCAGCGTCATCTTCATCACCTGCATCAGCCTCAACCGC 1680

561 Y L G I V H P F F A R S H L R P K H A W 580
1681 TACCTGGGCATCGTGACCCCTTCTTCGCCCCGAAGCCACCTGGCAGCCCAAGCAGCCTGG 1740

581 A V S A A G W V L A A L L A M P T L S F 600
1741 GCCGTGAGCGCTGCCGGTGGGTCTGGCCGCTGCTGGCCATGCCACACTGAGCTTC 1800

601 S H L K R P P Q Q G A G N C S V A R P E 620
1801 TCCCACCTGAAGAGGCCCGCCGAGCAGGGGGCGGGCAACTGCAGCGTGCCAGGCCCGAG 1860

621 A C I K C L G T A D H G L A A Y R A Y S 640
1861 GCCTGCATCAAGTGTCTGGGGACAGCAGACCAGGGCTGGCGGCTACAGAGCGTATAGC 1920

641 L V L A G L G C G L P L L L T L A A Y G 660
1921 CTGGTGCTGGCGGGGTGGGGCTGCGGCCTGCCGCTGCTGCTCACGCTGGCAGCCTACGGC 1980

661 A L G R A V L R S P G M T V A E K L R V 680
1981 GCCCTCGGGCGGGCCGTGCTACGCAGCCAGGCATGACTGTGGCCGAGAAGCTGCGTGTG 2040

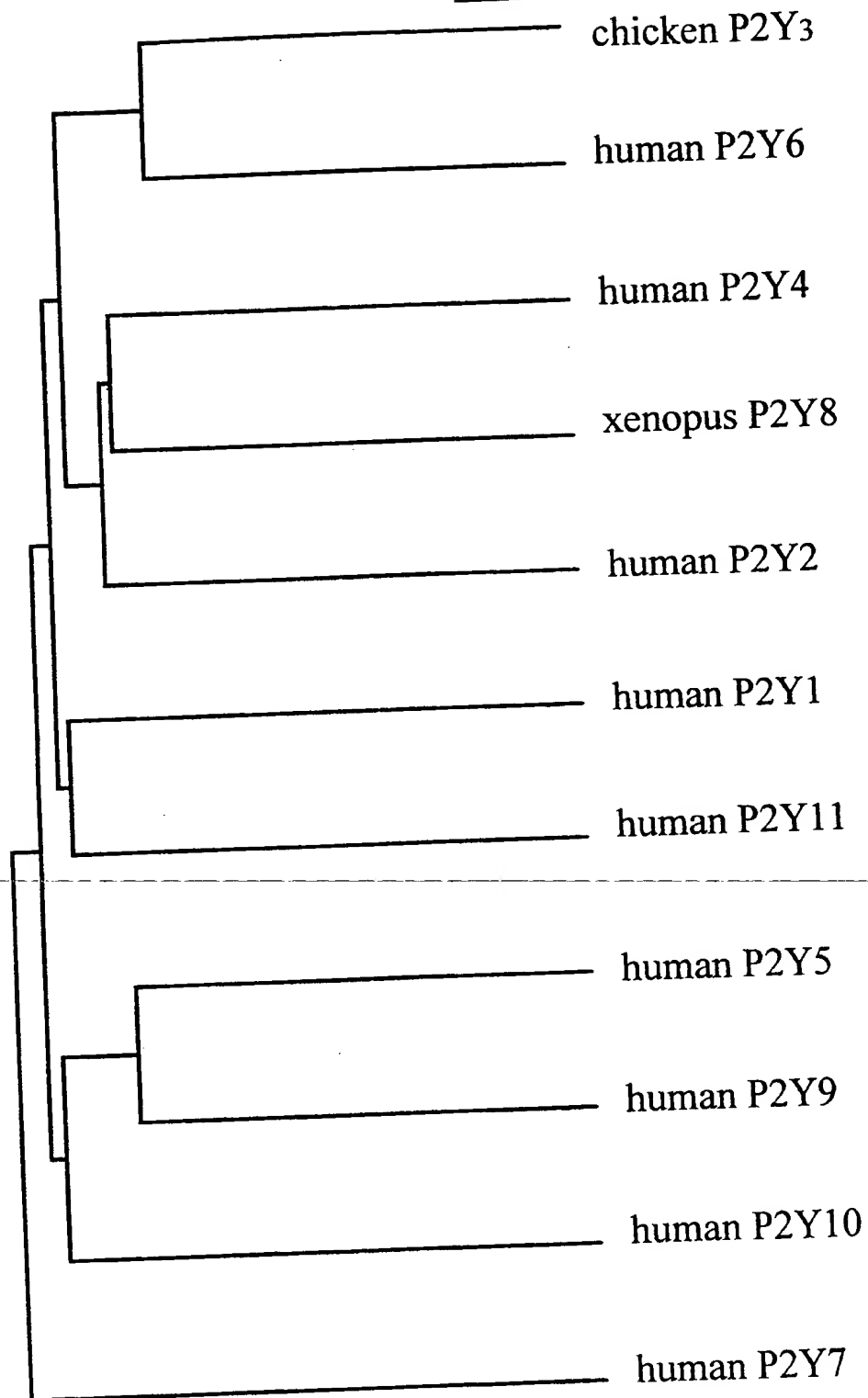
681 A A L V A S G V A L Y A S S Y V P Y H I 700
2041 GCAGCCTTGGTGGCCAGTGGTGTGGCCCTCTACGCCAGCTCCTATGTGCCCTACCACATC 2100

701 M R V L N V D A R R R W S T R C P S F A 720
2101 ATGCGGGTGCTCAACGTGGATGCTCGGCGGGCGCTGGAGCACCCGCTGCCCCGAGCTTTGCA 2160

721 D I A Q A T A A L E L G P Y V G Y Q V M 740
2161 GACATAGCCCCAGGCCACAGCAGCCCTGGAGCTGGGGCCCTACGTGGGCTACCAGGTGATG 2220

741 R G L M P L A F C V H P L L Y M A A V P 760
2221 CGGGGCCTCATGCCCCCTGGCCTTCTGTGTCCACCCTCTACTCTACATGGCCGCAGTGCCC 2280
761 S L G C C C R H C P G Y R D S W N P E D 780
2281 AGCCTGGGCTGCTGCTGCCGACACTGCCCCGGCTACAGGGACAGCTGGAACCCAGAGGAC 2340
781 A K S T G Q A L P L N A T A A P K P S E 800
2341 GCCAAGAGCACTGGCCAAGCCCTGCCCCTCAATGCCACAGCCGCCCTAAACCGTCAGAG 2400
801 P Q S R E L S Q *
2401 CCCAGTCCCGTGAGCTGAGCCAATGA

FIG.1c

FIG. 2

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FIG. 3

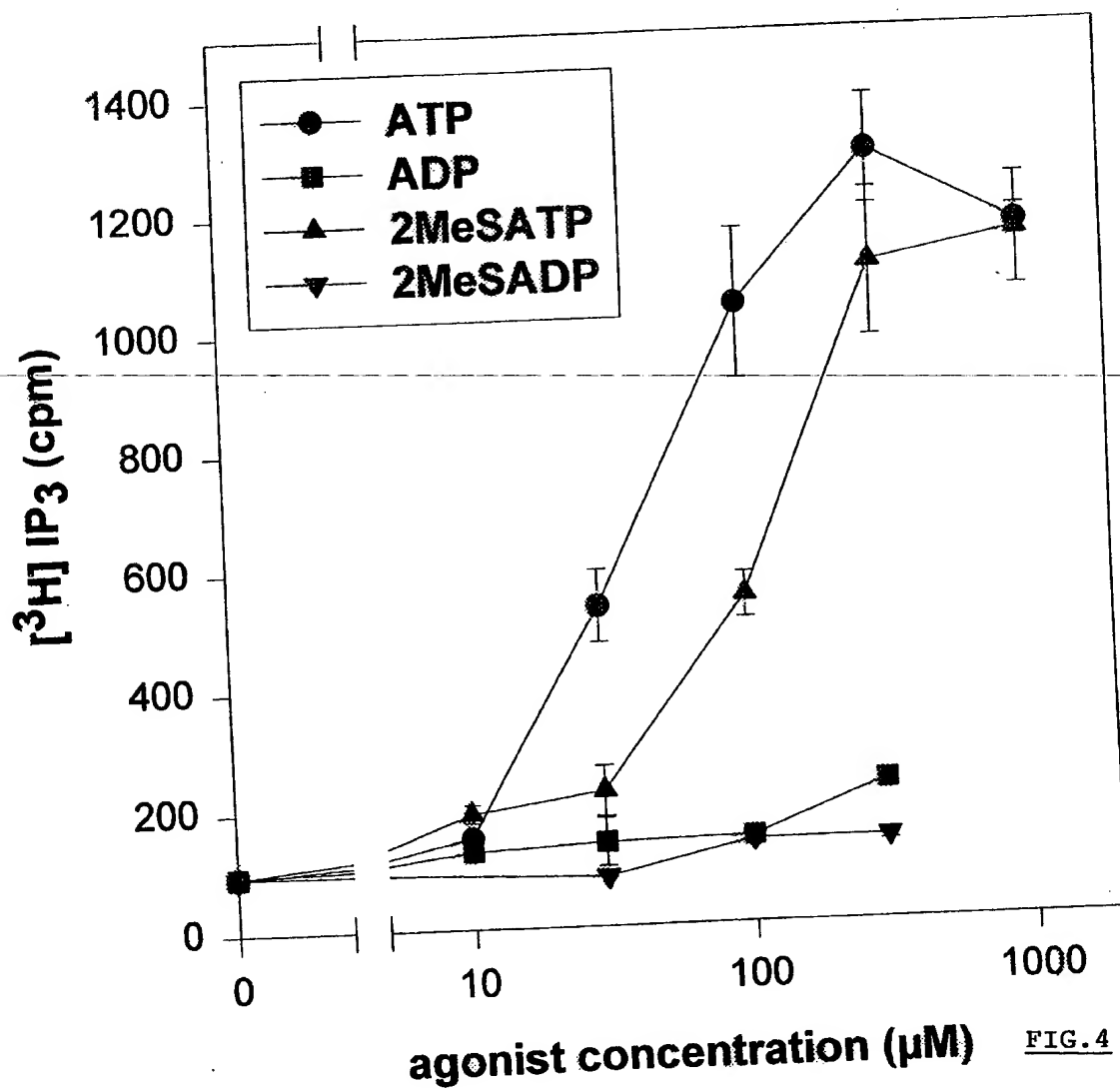
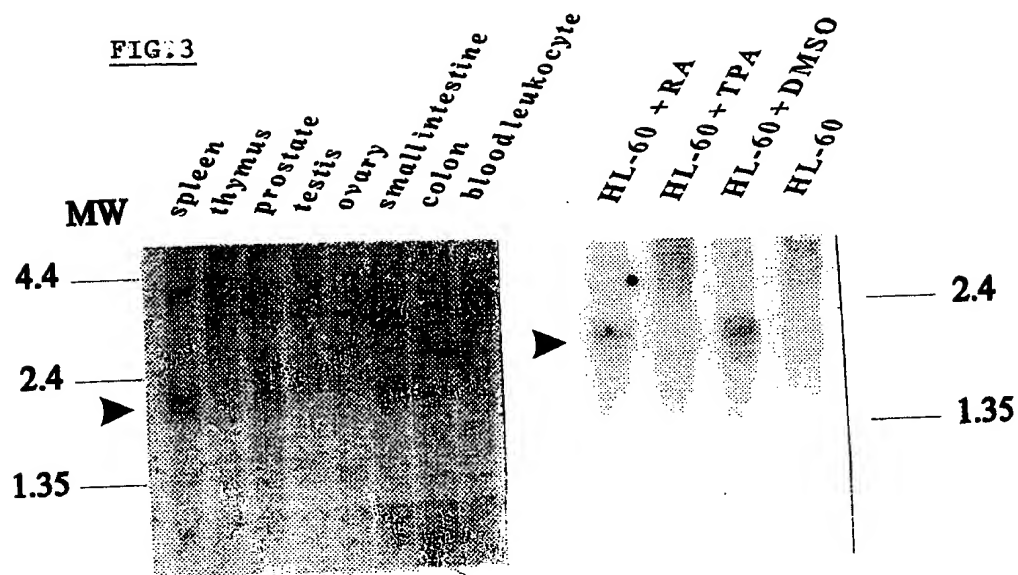


FIG. 4

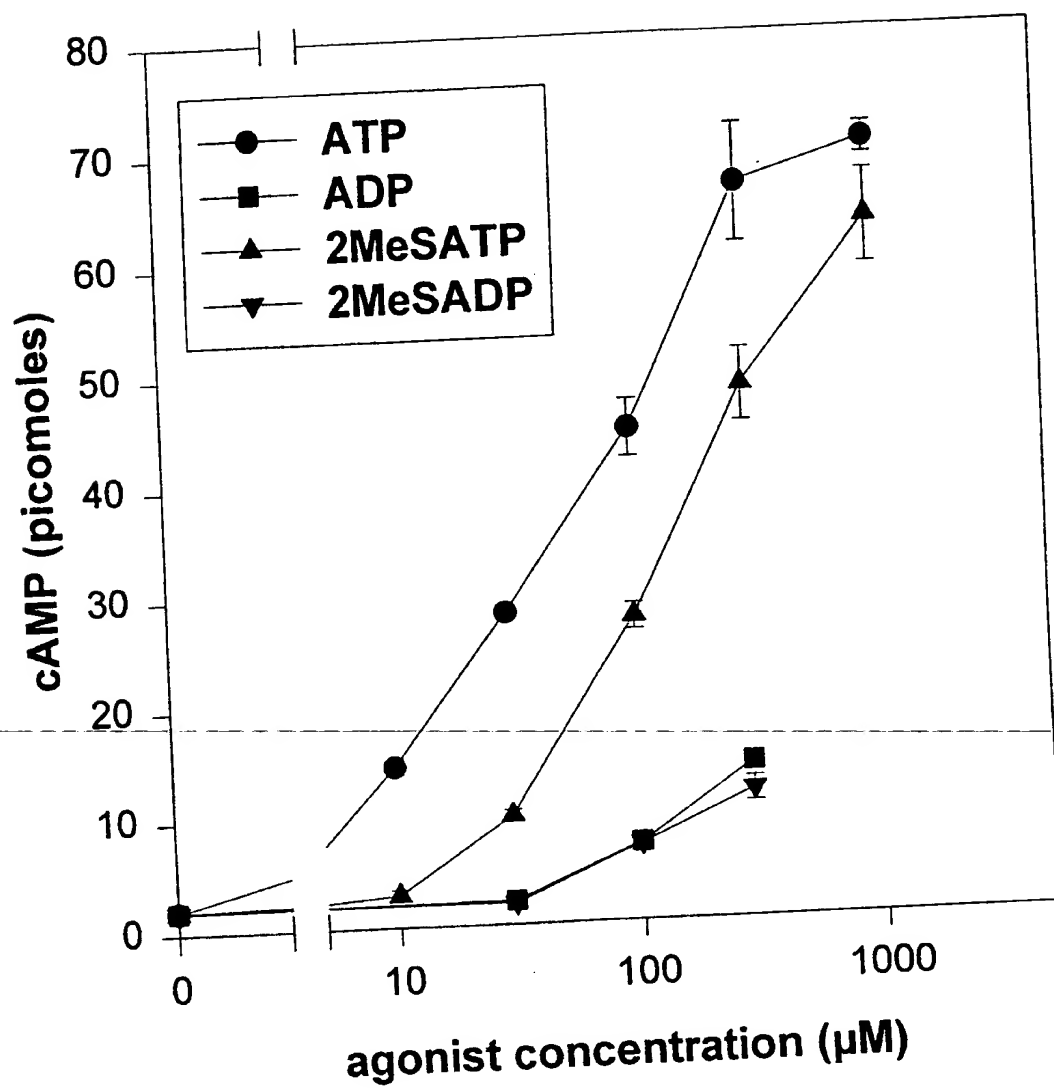


FIG. 5

INTERNATIONAL SEARCH REPORT

Int lional Application No
PCT/BE 98/06108

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C12N15/12 C12N5/10 C07K14/705 C07K16/28 C12Q1/68
G01N33/50 G01N33/566 A61K31/70 A01K67/027

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C12N C07K C12Q G01N A61K A01K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>DATABASE GENBANK Accession No. AA321112, 19 April 1997 ADAMS M.D. ET AL.: "EST 23640, H. sapiens cDNA similar to S. cerevisiae YHR066w (SSF1)" XP002083514 compare nt 1-312 with nt 340-650 of seq. ID 1</p>	<p>1,2, 7-17,19, 20</p>
A	<p>WO 97 20045 A (COR THERAPEUTICS INC) 5 June 1997 see abstract see page 15, line 21 - page 29, line 9 -/-</p>	<p>1-68</p>

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

6 November 1998

Date of mailing of the international search report

23/11/1998

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Authorized officer

Galli, I

INTERNATIONAL SEARCH REPORT

In. tional Applic. No
PCT/BE 98/05108

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		Relevant to claim No.
Category *	Citation of document, with indication, where appropriate, of the relevant passages	
A	COMMUNI D. & BOEYNAEMS J.M.: "Receptors responsive to extracellular pyrimidine nucleotides" TRENDS IN PHARM. SCI., vol. 18, March 1997, pages 83-86, XP002083512 see the whole document	1-68
P,X	COMMUNI D. ET AL.: "Cloning of a human purinergic P2Y receptor coupled to phospholipase C and adenylyl cyclase." J. BIOL. CHEM., vol. 272, no. 51, 19 December 1997, pages 31969-31973, XP002083513 see the whole document	1-20, 42-44, 48,50, 52,56,67

INTERNATIONAL SEARCH REPORT

International application No.

PCT/BE 98/00108

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
The ligands, antiligands, agonists and antagonists mentioned in claims 24-26, 35, 46, 47, 54, 55, 61, 62, 64, 65, 68 are not sufficiently disclosed in the description to allow a meaningful and complete search of the subject.
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.

PCT/BE 98/00108

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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05-06-1997

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